Injury and Fitness Outcomes During Implementation of Physical Readiness Training

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Abstract

This study examined injury and physical fitness outcomes in Basic Combat Training (BCT) during implementation of Physical Readiness Training (PRT). PRT is the U.S. Army's emerging physical fitness training program. An experimental group (EG, n = 1284), which implemented the PRT program, was compared to a control group (CG, n = 1296), which used a traditional BCT physical training program during the 9-week BCT cycle. Injury cases were obtained from recruit medical records and physical fitness was measured using the U.S. Army Physical Fitness Test (APFT, consisting of push-ups, sit-ups and a two-mile run). Injury rates were examined using Cox regression after controlled for initial group differences in demographics, fitness and other variables. Compared to the EG, the adjusted relative risk of a time-loss overuse injury in the CG was 1.5 (95% confidence interval [CI] = 1.0 – 2.1, $p < 0.01$) for men and 1.4 (95%CI = 1.1 – 1.8, $p < 0.01$) for women. There were no differences between groups for traumatic injuries. On the first administration of the final APFT, the EG had a greater proportion of recruits passing the test than the CG (men: 85% vs. 81%, $p = 0.04$; women: 80% vs. 70%, $p < 0.01$). After all APFT retakes, the EG had significantly fewer APFT failures than the CG among the women (1.6% vs. 4.6%, $p < 0.01$) but not the men (1.6% vs. 2.8%, $p = 0.18$); the gender-combined EG had a higher pass rate (1.6% vs. 3.7%, $p < 0.01$). Overall, the PRT program reduced overuse injuries and allowed a higher success rate on the APFT.

Key words
Military personnel · physical education training · gymnastics demography · muscle contraction

Introduction

Physical training has long been a job requirement for soldiers in the U.S. Army. Army training policy prescribes that commanders and supervisors will conduct exercise periods 3 to 5 days a week with sufficient intensity, frequency and duration to maintain adequate cardiorespiratory endurance, muscular strength and endurance, flexibility and body composition [7]. Specific guidance for developing programs is described in Army Field Manual (FM) 21 – 20 [5]. This guidance is based on specific principles of physical training [1,13,39,42] that have been adapted for military operations based on the experiences of soldiers and advice of consultants who have reviewed and modified the manual and programs contained therein.

Recently, the U.S. Army Physical Fitness School (USAPFS) proposed major modifications to Army physical training and developed a new program called Physical Readiness Training (PRT). PRT differs from current training practices in that it de-emphasizes running, provides a greater variety of exercises, integrates training elements resurrected from previous U.S. Army training manuals [2,3,8], and incorporates procedures and principles designed to reduce injuries and increase functional fitness [23,25,32,42].

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14. ABSTRACT

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The purpose of this study was to examine fitness and injury outcomes during implementation of the new PRT program in Basic Combat Training (BCT). BCT is where new recruits are introduced to the methods and practices of the U.S. Army and develop the basic skills and physical capabilities to become soldiers.

Methods

The PRT program was integrated into BCT in three phases: 1) train-the-trainer phase, 2) pilot phase and 3) test phase. During the train-the-trainer phase, personnel from the USAPFS provided experimental group (EG) training personnel (drill sergeants and staff) with 32-hours of practical, interactive instruction on how to conduct the PRT exercises. The pilot study phase involved an entire BCT cycle during which the trainers in the EG implemented the PRT exercises. Daily observations and focus group sessions with training personnel resulted in further program modifications. In the test phase, the PRT program was fully implemented by the EG without further changes during a full 9-week BCT cycle.

This paper reports on the results of the test phase. The test phase involved a quasi-experimental design comparing medical records and training data in two BCT battalions. The EG used the new PRT program while a control group (CG) used a traditional U.S. Army physical training program. The CG began training one week before the EG, and the CG was selected on the basis of this proximity of training time and similarity of injury rates in past BCT cycles.

Physical training programs

Physical training was performed for about one hour in the early morning hours (6:00 to 7:00 AM). BCT consists of numerous other physical activities (besides physical training), which are well standardized and vary little among battalions [34].

The traditional physical training program of the CG [4] involved primarily warm-up and stretching exercises followed by calisthenics, variations on push-up and sit-up exercises and running in formation. The latter was done in four "ability groups" established on the basis of run times on the initial Army Physical Fitness Test (APFT, described below). Soldiers ran with their ability groups, maintaining their position in formation. Training personnel led the runs and selected the pace.

The PRT program of the EG involved 6 different types of exercises: calisthenics, dumbbell drills, movement drills, interval training, long-distance running and flexibility training. Calisthenic exercises were performed to a slow or moderate cadence and consisted of the bend and reach, squat thrust, rower, squat bender, side-squat, bent leg body twist, squat and twist, squat stepper and the push-up [6]. After the third week of training, the EG supplemented these calisthenics with timed-sets of push-ups and sit-ups. Dumbbell drills were performed with 5 to 10 lb dumbbells for men and 3 to 10 lb dumbbells for women with one dumbbell held in each hand. Exercises included the lift and carry, bent-over row, rear lunge, shoulder raise, forward lunge, arm curl and overhead press [6]. For both calisthenics and dumbbell drills, four repetitions were executed at a slow cadence until recruits developed the correct form. Repetitions were increased by one in each subsequent exercise period until sets of 10 repetitions could be performed with precision. As training progressed, less rest was given until the only pause between exercises was for the instructor to name the next exercise.

Movement drills included events designed to improve speed and agility and included verticals, lateral shuffle, crossovers, skipping and cuts [6]. Soldiers lined up in columns and performed a particular drill over a 30 to 50 yard distance. When all recruits had completed a particular exercise, the direction was reversed and the drills repeated. Racing was not allowed but intensity was increased by reducing rest time between repetitions.

Interval training involved sprints of 30 seconds followed by 30 seconds of walking (30/30 runs). The sprints were performed at 70% of the recruit's maximal speed. Maximal speed was determined in a single session by having the recruits run a maximal effort 200-meter sprint and then read their 70% value from a chart. Sprints were performed after a warm-up that included calisthenics and movement drills. Limited formation running was also performed (as described above), gradually increasing distance from 0.8 to 4.0 kilometers.

Flexibility exercises were performed at the end of the exercise session. Stretches included the neck stretch, side stretch, chest stretch, hip flexor stretch, posterior hip stretch, hamstring stretch, thigh stretch, calf stretch, and trunk flexion and extension [6]. The stretches were held for 30 seconds and generally only performed once per session.

Physical characteristics, demographics, and lifestyle characteristics

Recruit physical characteristics were obtained from the medical examination form in the recruit's medical record. Variables included gender, date of birth, stature and body weight. Age was calculated from date of birth to the first day of training. Body mass index (BMI) was calculated as body weight/stature^2 [27]. Demographic data were obtained from records maintained in the training company. Variables included race, marital status, rank, citizenship status, educational level and service component (regular Army, Army reserves, or Army national guard). A questionnaire was administered that asked recruits about lifestyle characteristics prior to BCT. Recruits were asked how often they exercised or played sports for 15 minutes or more in the last month and to classify their smoking habits in the last year.

Categories of recruits

There were five categories of recruits: full cycle, discharges, newstart-outs, newstart-ins and Fitness Assessment Program (FAP) personnel. Full cycle recruits were those who began on the first day of basic training and graduated after completing all requirements 9 weeks later. Discharges were those who were released from their service obligation before completion of BCT, usually because of medical conditions that existed before service or because of inadequate performance. Newstart-outs were recruits who could not complete one or more training requirements within the 9-week period and were given additional time to do so in another unit (lost to follow-up for this study). Newstart-ins were recruits coming into a group after training had started because they could not complete one or more training re-

quirements in their previous BCT unit. FAP personnel were those who did not pass an entry level fitness test and were given additional time prior to BCT to improve their fitness under the supervision of specially trained personnel. The CG and EG provided lists of the various categories of recruits and the dates they left and/or entered the EG or CG. Lists were cross checked with other rosters (where available) to assure all recruits were accounted for and the dates were correct.

Injury outcomes

To obtain injury data, recruit medical records were screened. An injury case was defined as an individual who sustained physical damage to the body and sought medical care as indicated by the medical record. Injury types included overuse and traumatic. Overuse injuries were presumably due to long-term energy exchanges resulting in cumulative microtrauma and included stress fractures, stress reactions, tendonitis, bursitis, fasciitis, overuse syndromes, strains and musculoskeletal pain (not otherwise specified). Traumatic injuries were presumably due to sudden energy exchanges resulting in abrupt tissue overload and included sprains, dislocations, fractures, blisters, abrasions, lacerations, contusions and pain (due to an acute event). For each injury case, information extracted from the medical record included the date of visit, diagnosis, anatomic location, disposition (outcome of the visit) and days of limited duty (if any).

Two levels of injury were examined. The first level (any injury) included all visits to a health care provider for any type of injury. The second level (a time-loss injury) included only those injuries that resulted in one or more days of limited duty. By combining injury types and levels, four injury outcome measures were obtained: any overuse injury, any traumatic injury, time-loss overuse injury and time-loss traumatic injury.

Physical fitness outcomes

To evaluate physical fitness, the Army Physical Fitness Test (APFT) was used [5,26]. The APFT consisted of three events: push-ups (maximum number completed in two minutes), sit-ups (maximum number completed in two minutes) and a two-mile run for time. The APFT was administered three times during training by trainers who were very familiar with the well-standardized test procedures [5]. These three APFT administrations were termed (in order) initial, diagnostic and final. Recruits must "pass" the final APFT by meeting certain age and gender adjusted criteria [5] before they can graduate from BCT. Recruits who failed to pass the first administration of the final APFT were allowed to retake the test, usually up to a maximum of 5 times. Recruits who failed to meet the passing criteria after all retakes were considered APFT failures.

Five outcome measures were obtained from the APFT data. Two outcomes were 1) the proportion of soldiers passing the final APFT on the first administration and 2) the proportion of soldiers who failed the final APFT after all retakes. For administrative reasons, it is desirable to have as many individuals pass the final APFT the first time so that resources required for retakes are minimized. The other three outcome measures were the actual scores on push-ups (repetitions), sit-ups (repetitions) and the two-mile run (time).

Training data

The EG and CG maintained records of distances run in formation. EG mileage accumulated during 30/30 runs and movement drills were not obtained because this could not be accurately determined. The number of physical training sessions was obtained from unit training schedules. There were 5 companies in each battalion and the number of training sessions differed slightly by company.

Data analysis

Analyses of demographics, physical characteristics and recruit types revealed some initial differences between groups. Multivariate Cox regression (a survival analysis technique) was used to examine relative group differences in time to the first injury while controlling for these initial differences. Covariates were all variables that differed ($p < 0.10$ for either gender) between groups. For categorical variables, simple contrasts with a baseline variable (defined with a risk ratio of 1.00) were used. Once a recruit had an injury, his or her survival time was terminated. Those not completing BCT had their times censored on the day they left the unit. Comparisons between groups were made using the Wald statistic with the risk of injury in the EG set at 1.0.

Chi-square statistics were used to compare the proportion of EG and CG recruits passing the first administration of the final APFT and the proportion failing after all retakes. Group differences in APFT events were compared using analysis of variance (ANOVA) and, where necessary, analysis of covariance (ANCOVA). The first analysis involved a one-way ANOVA comparing the EG and CG on their initial APFT scores. If there were no significant differences on the initial APFT, a 2×3 (groups × tests) mixed model analysis was performed comparing the 2 independent groups and 3 repeated tests. If there were significant differences on the initial APFT, an ANCOVA was performed. The covariate was the initial test and a 2×2 mixed model ANCOVA involved the two groups over the 2 remaining tests (diagnostic and final). The Statistical Package for the Social Sciences (SPSS, Version 10.0.5, Chicago IL) was used for all analyses.

Results

The total cohort consisted of 2580 recruits. There were 1284 recruits in the EG (769 men, 515 women) and 1296 recruits in the CG (645 men, 651 women).

Physical characteristics, demographics and recruit categories

The CG had a greater proportion of women than the EG (50.2% vs. 40.1%, $p < 0.01$). Table **1** shows that there were only small differences in physical characteristics between the two groups.

Table **2** shows group comparisons for demographics and lifestyle characteristics. Most variables were very similar for the two groups but there were some differences. A larger proportion of men in the EG were Army Reservists and fewer were Regular Army compared to the CG. A similar trend was noted for the women. More EG women were married compared to CG women, but this was not seen among the men.

Table 1 Comparison of Physical Characteristics in the Experimental and Control Groups

Variable	Group[a]	Men N	Men Mean	Men SD	Men p-value[b]	Women N	Women Mean	Women SD	Women p-value[b]
Age (years)	EG	759	20.9	3.4	0.13	505	20.9	3.7	0.09
	CG	630	20.7	3.3		637	20.7	3.4	
Stature (cm)	EG	758	176.5	7.4	0.18	507	164.1	6.4	0.13
	CG	629	176.0	7.1		636	163.6	6.4	
Weight (kg)	EG	758	75.6	13.3	0.23	507	62.0	9.7	0.15
	CG	628	74.4	12.6		636	61.2	9.1	
BMI[c] (kg/m^2)	EG	758	24.3	3.8	0.21	507	23.0	3.1	0.64
	CG	627	24.0	3.7		635	22.9	2.9	

[a]EG = Experimental Group; CG = Control Group
[b]From Analysis of Variance comparing groups
[c]BMI = Body Mass Index

Table 2 Demographic and Lifestyle Comparison of Experimental and Control Groups

Variable	Category	Men EG Proportion of Variable (%)	Men CG Proportion of Variable (%)	Men p-value[a]	Women EG Proportion of Variable (%)	Women CG Proportion of Variable (%)	Women p-value[a]
Race	White[e]	58.3	53.2		49.3	43.3	
	Black[e]	23.8	29.6		33.6	40.2	
	Hispanic[e]	12.5	11.5	0.22	9.7	10.3	0.14
	Asian[e]	2.6	2.9		3.7	4.0	
	American Indian[e]	1.6	1.2		2.1	1.2	
	Other	1.3	1.6		1.6	0.9	
Marital Status	Single	87.9	87.7	0.89	85.3	89.0	0.06
	Married	12.1	12.3		14.7	11.0	
Rank[b]	Private One	60.8	60.3		53.3	54.0	
	Private Two	21.8	19.2	0.24	21.5	20.8	0.87
	Private First Class	13.9	15.4		17.3	18.4	
	Specialist	3.4	5.2		7.9	6.8	
Citizenship	Native Born	93.4	92.8		92.8	89.9	
	Naturalized	2.5	2.4	0.82	2.0	3.5	0.18
	Not Citizen	4.0	4.7		5.2	6.7	
Education	<High School[c]	0.3	0.3		0	0	
	High School Grad	82.0	80.9		81.1	85.2	
	GED[d]	12.9	11.0	0.12[c]	8.2	7.0	0.14[c]
	1 – 3 Years College	2.0	3.2		4.6	2.4	
	College Grad	2.8	4.5		6.0	5.4	
Service Component	Regular Army	73.7	78.2		69.7	73.7	
	Army Reserve	13.1	8.6	0.03	14.7	10.5	0.10
	National Guard	13.1	13.2		15.5	15.8	
Exercise or Sport Frequency Prior to BCT[e]	None	8.2	5.8		10.4	10.2	
	< 1 per week	13.7	11.2		14.5	16.9	
	1per week	17.4	16.7	0.13	18.8	20.0	0.78
	2 to 3 per week	37.4	37.9		39.6	37.4	
	4 or more per week	23.7	28.4		16.7	15.5	
Cigarette Smoking Prior to BCT[e]	None	54.9	59.5		58.0	62.6	
	Smoked but quit	9.9	9.0		12.0	9.4	
	1 – 10 cig per day[f]	11.2	10.5	0.51	11.8	12.0	0.47
	11 – 20 cig per day[f]	14.8	12.2		13.1	11.1	
	> 20 cig per day[f]	9.3	8.7		5.1	5.0	

[a]The p-values are from the chi-square statistic comparing CG and EG
[b]Each successive category represents a higher rank
[c]< High School was not included in chi-square calculation
[d] GED = General Education Development Certificate
[e]BCT = Basic Combat Training
[f]cig = Cigarettes

Table **3** compares the two groups on the proportion of individuals in each recruit category. There were no significant differences between the EG and CG on the proportion of full cycle or newstart recruits. More of the EG men were discharged and the EG had a significantly larger proportion of FAP men and women.

Injury outcomes

The proportion of recruit medical records obtained and reviewed were 98.6% in the EG and 98.1% in the CG. For the multivariate Cox regression, independent variables included age, marital status, service component, FAP status, sit-up performance and two-mile run time (these had initial group differences with $p < 0.10$). Age, sit-up performance and two-mile run times were entered as continuous variables while the rest were entered as categorical.

Table **3** Comparison of Recruit Categories in Experimental and Control Groups

Categories	*Gender*	*N*		*Proportion of Respective Group (%)*		*p-value*[c]
		EG[a]	*CG*[b]	*EG*[a]	*CG*[b]	
Full cycle	Men	688	583	89.5	90.4	0.57
	Women	446	561	86.6	86.2	0.83
Discharges	Men	27	12	3.5	1.9	0.06
	Women	25	33	4.9	5.1	0.87
Newstart-outs	Men	39	27	5.0	4.2	0.43
	Women	34	37	6.6	5.9	0.64
Newstart-ins	Men	17	24	2.2	3.7	0.19
	Women	10	21	1.9	3.2	0.18
FAP[d]	Men	33	15	4.3	2.3	0.04
	Women	90	69	17.5	10.6	<0.01

[a]EG = Experimental Group
[b]CG = Control Group
[c]From chi-square statistic
[d]FAP = Fitness Assessment Program personnel

Table **4** shows that after adjustment for initial group differences, the relative risk of any overuse injury was 52% higher in the CG men and 46% higher in the CG women, compared to the EG men and women. Table **5** shows that there were no significant differences between the CG and EG for traumatic injuries. Table **6** shows that after adjustment, the relative risk of a time-loss overuse injury was 47% higher in the CG men and 39% higher in the CG women, compared to the EG men and women. Table **7** shows that there were no significant differences between the EG and CG for time-loss traumatic injuries.

Physical fitness outcomes

There were no differences between the EG and CG in the proportion of recruits passing the initial APFT (men: 40% vs. 43%, respectively, $p = 0.34$; women: 31% vs. 30%, respectively, $p = 0.93$). The EG had a higher pass rate on the first administration of the final APFT, both among the men (85% vs. 80%, $p = 0.04$) and the women (80% vs. 70%, $p < 0.01$). After all retakes of the final APFT, there were no significant differences among the EG and CG male failures (1.7% vs. 2.8%, respectively, $p = 0.18$), but the EG women had fewer APFT failures than the CG women (1.6% vs. 4.6%, $p < 0.01$). When men and women were combined, the EG had fewer APFT failures that the CG (1.6% vs. 3.7%, $p < 0.01$).

Table **8** shows the results for each APFT event. On the push-ups, there were no significant differences between groups on the initial test for men ($p = 0.14$) or women ($p = 0.43$). The 2 × 3 ANOVA for both men and women, demonstrated significant main effects for groups ($p < 0.01$) and tests ($p < 0.01$); the groups × test interaction was also significant ($p < 0.01$). The performance of the CG was higher than that of the EG.

For the men on the sit-ups, there were no significant differences between groups on the initial sit-up test ($p = 0.21$). The 2 × 3 ANOVA demonstrated no significant main effect for groups ($p = 0.23$) but the main effect for tests ($p < 0.01$) and the groups

Table **4** Multivariate Cox Regression Results for Overuse Injuries

Variable	*Men*			*Women*		
	Adjusted Relative Risk	*95% Confidence Interval*	*p-value*[a]	*Adjusted Relative Risk*	*95% Confidence Interval*	*p-value*[a]
Group[b]						
EG	1.00	–	–	1.00	–	–
CG	1.52	1.12–2.07	<0.01	1.46	1.19–1.80	<0.01
FAP						
No	1.00	–	–	1.00	–	–
Yes	1.29	0.62–2.65	0.50	1.27	1.00–1.71	0.08
Marital Status						
Single	1.00	–	–	1.00	–	–
Married	0.87	0.54–1.42	0.58	1.09	0.81–1.46	0.58
Component						
Regular Army	1.00	–	–	1.00	–	–
Reserves	0.96	0.59–1.55	0.85	0.94	0.68–1.28	0.68
NG[c]	0.89	0.55–1.43	0.63	0.89	0.67–1.17	0.40
Age	1.06	1.02–1.11	<0.01	1.01	0.98–1.04	0.47
Sit-Ups	1.01	0.99–1.02	0.28	0.99	0.98–1.00	<0.01
Two-Mile Run	1.12	1.05–1.18	<0.01	1.05	1.01–1.09	0.02

[a]From Wald statistic
[b]EG = Experimental Group; CG = Control Group
[c]NG = National Guard

Table 5 Multivariate Cox Regression Results for Traumatic Injuries

Variable	Men			Women		
	Adjusted Relative Risk	95% Confidence Interval	p-value[a]	Adjusted Relative Risk	95% Confidence Interval	p-value[a]
Group[b]						
EG	1.00	–	–	1.00	–	–
CG	1.03	0.62 – 1.72	0.90	0.92	0.60 – 1.41	0.70
FAP						
No	1.00	–	–	1.00	–	–
Yes	3.09	1.29 – 7.40	< 0.01	1.56	0.92 – 2.66	0.10
Marital Status						
Single	1.00	–	–	1.00	–	–
Married	1.19	0.55 – 2.58	0.66	0.90	0.48 – 1.71	0.75
Component						
Regular Army	1.00	–	–	1.00	–	–
Reserves	0.62	0.25 – 1.56	0.31	0.75	0.36 – 1.56	0.43
NG [c]	0.58	0.23 – 1.45	0.24	1.21	0.71 – 2.08	0.49
Age	1.01	0.93 – 1.09	0.83	1.04	0.98 – 1.09	0.20
Sit-Ups	1.01	0.99 – 1.03	0.38	1.00	0.99 – 1.02	0.73
Two-Mile Run	1.10	1.00 – 1.21	0.06	1.07	0.98 – 1.16	0.12

[a]From Wald statistic
[b]EG = Experimental Group; CG = Control Group
[c]NG = National Guard

Table 6 Multivariate Cox Regression Results for Time-Loss Overuse Injuries

Variable	Men			Women		
	Adjusted Relative Risk	95% Confidence Interval	p-value[a]	Adjusted Relative Risk	95% Confidence Interval	p-value[a]
Group[b]						
EG	1.00	–	–	1.00	–	–
CG	1.47	1.02 – 2.10	0.04	1.39	1.10 – 1.76	< 0.01
FAP						
No	1.00	–	–	1.00	–	–
Yes	1.41	0.65 – 3.08	0.33	1.29	0.95 – 1.73	0.06
Marital Status						
Single	1.00	–	–	1.00	–	–
Married	1.03	0.60 – 1.76	0.98	1.13	0.81 – 1.58	0.50
Component						
Regular Army	1.00	–	–	1.00	–	–
Reserves	0.56	0.29 – 1.12	0.10	1.12	0.80 – 1.58	0.49
NG [c]	0.94	0.55 – 1.61	0.76	0.81	0.58 – 1.13	0.28
Age	1.07	1.02 – 1.12	< 0.01	1.01	0.97 – 1.04	0.70
Sit-Ups	1.00	0.99 – 1.02	0.70	0.99	0.98 – 1.00	0.01
Two-Mile Run	1.15	1.08 – 1.22	< 0.01	1.06	1.01 – 1.10	0.03

[a]From Wald statistic
[b]EG = Experimental Group; CG = Control Group
[c]NG = National Guard

× tests interaction was significant ($p < 0.01$). For the women on the sit-ups, the EG performed an average of 3 more sit-ups on the initial test ($p < 0.01$). After adjustment for this initial difference with ANCOVA, there were significant main effects for groups ($p < 0.01$) and tests ($p < 0.01$) and the groups × test interaction was also significant ($p < 0.01$).

For the 2-mile run, there were significant differences between groups on the initial test for both men ($p < 0.01$) and women ($p < 0.01$). The CG men and women both ran an average of about 36 seconds faster than the EG men and women. After adjustment for these initial differences with ANCOVA, there were significant main effects for the tests ($p < 0.01$, men and women) but not for groups ($p = 0.15$ men, $p = 0.54$ women) and the groups × tests interaction was not significant ($p = 0.25$ men, $p = 0.26$ women).

Training data

Table 9 contains the formation running mileage and number of training sessions conducted by the two groups. The CG had more than double the formation running mileage of the EG. The average number of training sessions was similar for the two groups.

Table 7 Multivariate Cox Regression Results for Time-Loss Traumatic Injuries

Variable	Men			Women		
	Adjusted Relative Risk	95% Confidence Interval	p-value[a]	Adjusted Relative Risk	95% Confidence Interval	p-value[a]
Group[b]						
EG	1.00	–	–	1.00	–	–
CG	0.82	0.43 – 1.58	0.60	0.90	0.55 – 1.47	0.68
FAP						
No	1.00	–	–	1.00	–	–
Yes	4.21	1.70 – 10.44	< 0.01	1.40	0.76 – 2.59	0.28
Marital Status						
Single	1.00	–	–	1.00	–	–
Married	1.38	0.56 – 3.41	0.49	1.39	0.71 – 2.72	0.34
Component						
Regular Army	1.00	–	–	1.00	–	–
Reserves	0.76	0.27 – 2.17	0.61	0.75	0.32 – 1.77	0.51
NG[c]	0.54	0.17 – 1.79	0.32	1.38	0.76 – 2.53	0.29
Age	1.02	0.93 – 1.12	0.65	1.02	0.95 – 1.09	0.61
Sit-Ups	1.00	0.97 – 1.03	0.80	1.00	0.98 – 1.02	0.79
Two-Mile Run	1.13	1.01 – 1.26	0.04	1.07	0.97 – 1.17	0.17

[a]From Wald statistic
[b]EG = Experimental Group; CG = Control Group
[c]NG = National Guard

Table 8 Comparison of APFT Scores of Experimental and Control Groups

Gender	Test	Group[a]	Push-Ups (reps)		Sit-Ups (reps)		Two-Mile Run (min)	
			Mean	SD	Mean	SD	Mean	SD
Men	Initial	EG	31.9	12.5	43.6	11.9	17.6	2.6
		CG	32.9	14.4	42.7	12.6	17.0	2.4
	Diagnostic	EG	41.7	13.0	52.6	12.2	15.6	1.8
		CG	47.1	14.3	55.1	14.2	15.2	1.8
	Final	EG	47.8	12.9	59.1	11.1	15.0	1.3
		CG	51.9	13.4	59.9	13.7	14.8	1.3
Woman	Initial	EG	10.1	8.9	37.3	13.8	21.7	2.8
		CG	10.3	9.3	34.4	13.9	21.1	2.6
	Diagnostic	EG	17.1	10.9	49.5	13.7	19.3	2.2
		CG	27.7	16.4	46.9	18.1	18.9	2.2
	Final	EG	23.5	11.4	58.5	12.1	18.4	1.6
		CG	31.5	17.4	52.7	18.2	18.2	1.7

[a]EG = Experimental Group; CG = Control Group

Table 9 Formation Running Distances and Training Sessions in Experimental and Control Groups

Group[a]	Statistic	Formation Running (miles)	Physical Training Sessions (n)
EG	Mean	17.1	34.0
	SD	1.9	2.4
CG	Mean	37.2	34.4
	SD	6.4	1.9
p-value[b]		< 0.01	0.78

[a] EG = Experimental Group; CG = Control Group
[b]From independent sample t-test (formation running) or chi-square statistic (physical training sessions)

Discussion

The EG which used the new PRT program had more favourable injury and fitness outcomes than the CG which used the traditional program. The EG had a lower rate of overuse injuries and a greater proportion of individuals passing the APFT. For scores on the individual APFT test items, there were no differences between groups on two-mile run improvements despite the greater training mileage in the CG. The EG women improved more on sit-ups than the CG women but there were no group differences among the men. The only unfavourable outcome for the EG was the lower final push-up score, but this lower score was still sufficient to pass the APFT and graduate from BCT.

Injuries

Risk factors for injuries in BCT have been well researched [25,34] and an attempt was made to control for or equalize between-group differences in these factors at the start of the study. Injury rates in the summer are higher than injury rates in the fall [28]. Examining two groups that were only one week apart in their training cycles minimized this seasonal factor. Older running shoes have been shown to be associated with higher stress fracture rates [14]. Since 1998, all recruits have been required to buy running shoes on entry to training so both groups began training with new running shoes. Low physical activity and cigarette smoking prior to BCT are known injury risk factors [14,24,34], but these lifestyle characteristics did not differ between the groups at the start of the study (Table **2**). Women are at higher injury risk than men in BCT [10,22,34,38] and since the CG had a higher proportion of women, gender-specific analyses were conducted. Hamstring flexibility, foot arch height, knee Q-angle and past ankle sprains are also known injury risk factors in BCT [11,12,24,34] but it was not possible to measure or control for these in this study.

There were other known injury risk factors that differed between the EG and CG at the start of the study that could not be controlled for administrative reasons or because the differences did not become apparent until the study was underway. These included differences in the proportion of FAP personnel [29], aerobic fitness [14,24,30,34], age and martial status [14,24,33]. Most of these differences placed the EG at higher estimated injury risk than the CG. Since these factors could not be directly controlled at the start of the study, *post hoc* adjustments were made using Cox regression. After Cox adjustment, overuse and traumatic injury risk in the CG increased relative to the EG. In no case were traumatic injuries significantly different between groups before or after the adjustment.

The PRT program was intentionally designed with reduced formation running mileage, which may partly account for the lower incidence of overuse injuries in the EG. Studies of runners and basic training recruits have strongly suggested that as the total amount of running increases, the incidence of injuries increases [23,36,37,41,46,49]. Other studies [45,47] suggest that substituting interval training for distance running may also reduce BCT injury rates, but these studies are confounded with multiple interventions making it difficult to determine the effectiveness of interval training alone.

Another factor that may partially account for the lower overuse injury incidence in the EG was the variety of exercises in the program. There are no studies indicating that a greater variety of exercise will reduce injuries but sports medicine professionals often recommend "cross-training" for this purpose [52]. The cross-training concept simply involves alternating different types of exercises on different days; exercises involving different fitness components (e.g., aerobic and strength) or different body parts can be used. Reducing the repetitive use of particular body parts or energy systems may allow more time for recovery and reduce the probability of overuse injuries.

Physical fitness

The PRT program did not strongly emphasize push-ups and sit-ups like the traditional program. In the EG, push-ups and sit-ups were integrated into the calisthenics program and were only given slightly more emphasis than the other calisthenic exercises. Despite this, the sit-up performance of the EG men was similar to that of the CG men, and the sit-up performance of EG women exceeded that of the CG women. The EG did not fare as well on push-ups, perhaps suggesting that the amount of push-up training should be increased in PRT. But, more EG men and women passed the APFT indicating that the lower EG push-up scores were still above "passing" levels [4]. Thus, adding more push-up training may not be advisable since it would reduce the time available for other training modalities and might detract from their benefits.

The actual push-up and sit-up training volume was not tracked in the two groups; however, observations made during training suggest the volume was much lower in the EG. Previous studies have shown that exercise focused on a specific muscular strength/endurance test will result in the greatest improvement on that test [9,15–19,32,43,48,51]. However, exercises that improve the muscular strength or muscular endurance of the muscle groups involved in a test can also improve test performance [21,31,32,48,50]. For this reason, the dumbbell and calisthenic drills that progressively exercised some of the same muscle groups involved in the push-up and sit-up tests may have aided in improving performance on these test events. Physiological mechanisms involved in the improvements from non-specific muscular strength/endurance training appear to include increases in muscle mass (especially in subjects with the lowest initial strength) and improved ability to use short-term energy sources (adenosinetriphosphate, creatine phosphate and glucose/glycogen) through increased substrate availability and changes in enzyme profiles [32,42]. If the training volume on a specific task becomes too great, performance gains can be minimal or actually decrease [40]. It is possible the training volume in the CG was high enough to cause performance decrements in some individuals.

Performance on the final two-mile run was almost identical for the EG and CG, despite the fact that the initial run times for the EG were 36 seconds slower and the total amount of formation running was considerably less than the CG. Previous basic training studies support the concept that much lower volumes of running can result in maximal effort run times similar to greater training volumes [23,49,53]. In the present study, the lower volume of formation running in the EG was supplemented by interval training and movement drills.

Another factor that may have contributed to the similar running times in the EG and CG is the fact that fewer EG individuals had their training interrupted by injury. Calculations using data from the present study indicated that 152 recruits in the EG experienced lower extremity time-loss overuse injuries compared to 220 in the CG. Thus, 68 more recruits in the EG (5% of the group) were able to perform lower body training without interruption.

The APFT is not strongly associated with military job performance or the capacity to perform functional soldering tasks

[20,35,44]. The APFT does not test mobility, dynamic coordination, strength and flexibility balances, and other components of human physical performance presumably influenced by the EG program [6]. However, the APFT was the fitness criteria used in this study for two reasons. First, it is the test that new recruits must pass to graduate from BCT, and later, to be retained in service. Thus, the APFT is the current Army standard for a successful physical fitness program. Second, the APFT is a generally valid measure of at least two components of physical fitness: cardiorespiratory endurance and muscular strength/endurance [26]. Thus, even though the APFT does not test all components that the EG program presumably enhanced, it did test some of these components.

In summary, the PRT program resulted in a lower risk of overuse injuries, higher first time pass rate on the APFT, and a lower rate of APFT failure when compared to traditional physical training in BCT. These outcomes suggest the PRT program should be employed in all BCT units.

Disclaimers

The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as official Department of the Army position, policy or decision, unless so designated by other official documentation.

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